Control System DFE 1

Application Hints and Start Up Instructions
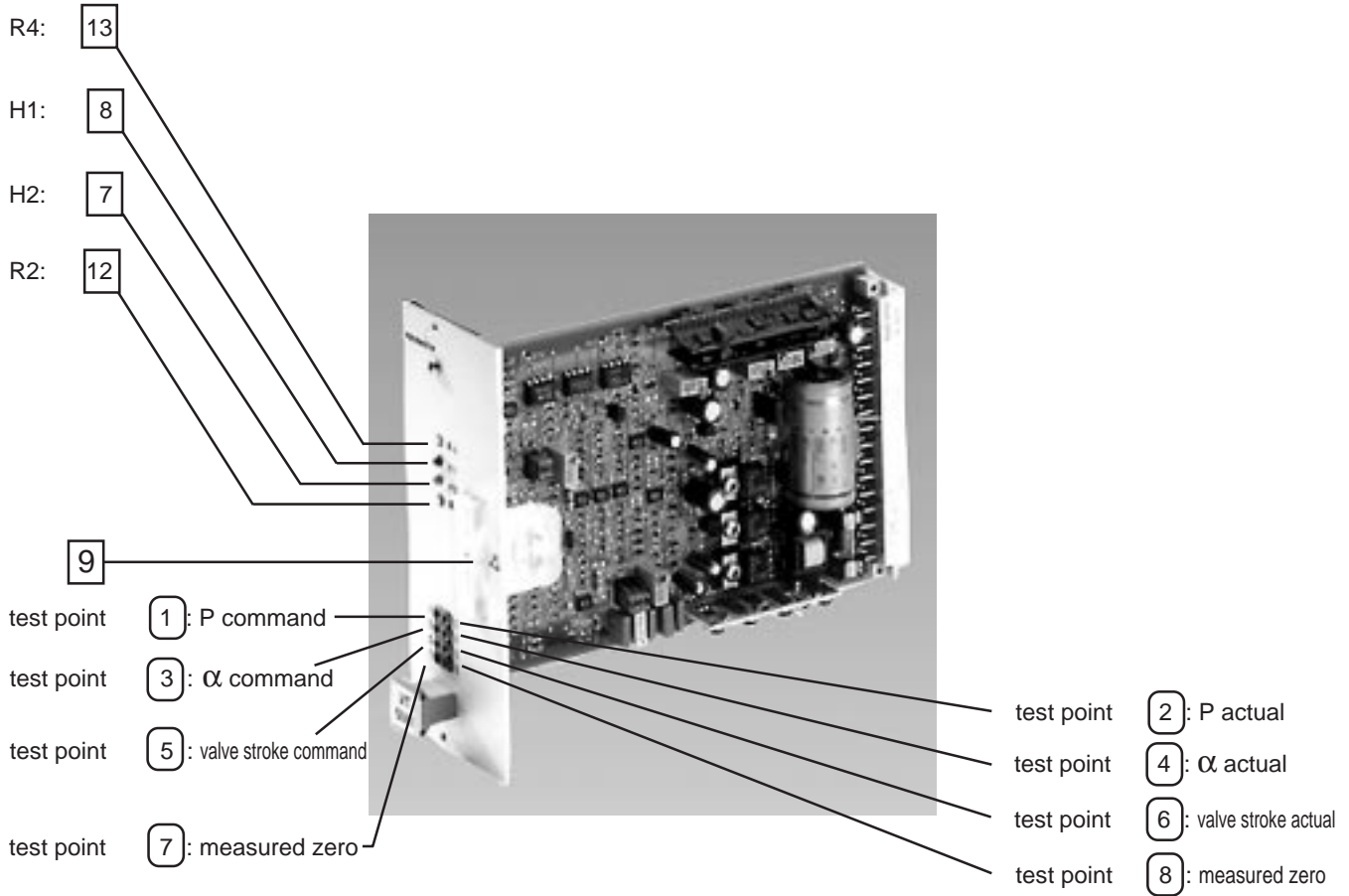
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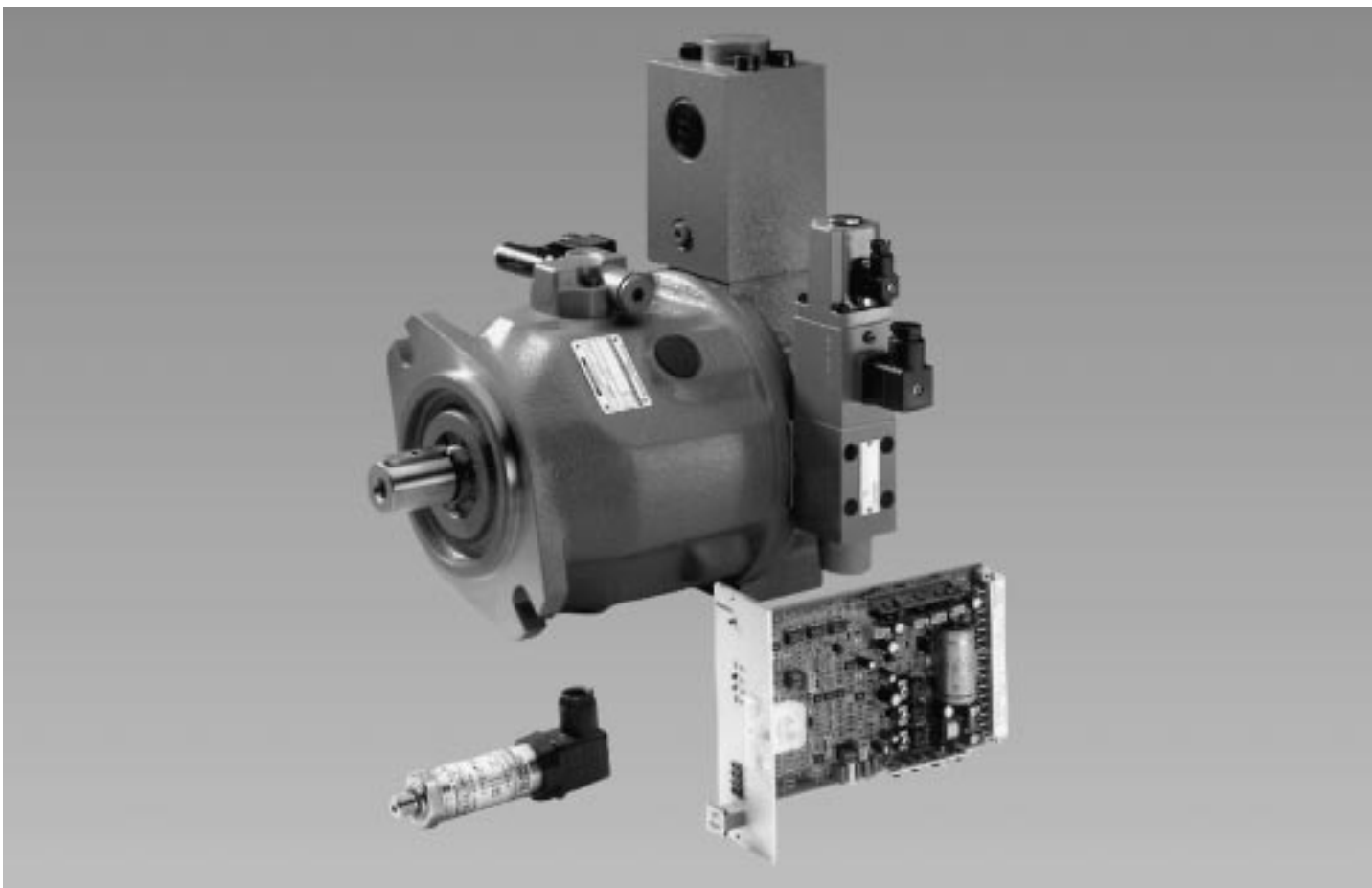
STRUCTURE OF
DFE1 - COMPLETE

	ref. potential	
4c	ref. potential	2
6c	0 ... 10 V P command	
16c	ref. potential	3
14c	0 ... 10 V Q command	

		1
28a	0 V	power supply 24 V = 3 A
30a	24 V	

26c	6
32a	24 V

5

Terminal strip

III

15

IMPORTANT INFORMATION

For a correct operation of the DFE1-control all shown terminals have to be connected.

Faulty wiring is the most common cause of malfunction during start up.

—> Make connections correctly !!

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STRUCTURE OF
CONTROL CARD
VT 5041 ⊞

R4: 13

H1: 8

H2: 7

R2: 12

9

test point 1 : P command

test point 3 : α command

test point 5 : valve stroke command

test point 7 : measured zero

test point 2 : P actual

test point 4 : α actual

test point 6 : valve stroke actual

test point 8 : measured zero

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INDEX INFORMATION

Main groups	I	A10VS with prop. valve, inductive pos. transducer for valve stroke and swivel angle
	II	pressure transducer HM 12
	III	Electr. control card VT 5041-2x (Block diagram see page 11)
	IV	Min. control pressure block (if required, otherwise primary relief valve is needed)
Index	1	Power supply
	2	Pressure, command value
	3	Swivel angle command value
	4	Shields for feed back wiring
	5	Cable for valve stroke transducer
	6	Function release
	7	Green LED H2: supply voltage for electr. control card
	8	Red LED H1: Malfunction
	9	Swivel angle indicator on front face of card (only VT 5041-2X/3...)
	10	Cable of swivel angle transducer
	11	Cable of prop. valve solenoid
	12	Potentiometer R2: alignment of pressure transducer
	13	Potentiometer R4: Leakage compensation
	14	Directionalvalve-Block: to hydraulic actuators
	15	Connector strip
	16	Cable of pressure transducer

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STRUCTURE AND CONNECTIONS OF DFE1-CONTROL SYSTEM

1. Structure
2. Hydraulic connections
3. Electrical connections

1. Structure

The DFE1-control (pressure- and flow control electrical) consists of the following components (see also the picture page 3):

| I. | A10VSO with prop. valve STW0063, a transducer for feedback of valve stroke, and a transducer for feedback of pump swivel angle. |

| II. | Pressure transducer HM 12 |

| III. | Electronic control card VT 5041-2X |

| IV. | Min. control pressure block SYDZ 0001, with integrated relief valve. |

Not included in the scope of supply is the following necessary hardware: (see also the picture on page 3)

Directional valve (e) |14| , hydraulic piping to the pressure transducer |II| and directional valve, tank connection T (to oil reservoir), piping for suction connection S and leak line L1 or L, all of the electrical cabling to the pressure transducer |II| , inductive position transducers |5| and |10| , the solenoid cable |11| for the proportional valve, the socket connector |15| , the power supply |1| , cabling for command value selection |2| and |3| and the enable input |6| connection.

2. Hydraulic connection (RE 92 711/03.93)

2.1 Suction line

S = connect the pump suction port with the reervoir. However, the following has to be taken into account: the permissible pressures (abs) must not be exceeded or fall below: 0.8 - 30 bar, the pipework must also be correctly installed: pipe diameter uninterrupted to pump port S.

2.2 Pressure line	P = pump pressure connection: piping to actuator to SAE, also see RE 92 711/03.93. It has to be noted, that if the minimum control pressure block IV is not used, a pressure relief valve has to be fitted into the pressure line, whose set pressure lies 20 % above the system pressure. If this valve is omitted, damage to the pump caused by faults could be possible. The electrical pressure control does not replace the pressure safety function.
2.3 Case drain line	L1, L = drain line: always pipe to the highest connection, no diameter reduction is permitted, drain line to be piped directly to the oil reservoir and end under the minimum oil level (errors in the drain line can lead to unpermissibly high housing pressure peaks).
2.4 Test connection for the pressure transducer	When used in conjuction with the minimum control pressure block IV the pressure tranducer used here HM12 II has to be fitted between the minimum pressure block and directional valve 14 in a **hanging position** (pressure connection at the top), to ensure optimum air bleed conditions for the pressure transducer. Care should be taken to ensure that no additional valves are fitted between the pump and pressure transducer other than the minimum pressure block. If the minimum pressure block is not required, the pressure transducer can be fitted directly at the pump or directional valve (or possibly manifold block). (Take note of the above guidelines). When connecting the pressure transducer use an adequately sized pipe diameter (no minimess hose!).

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3. Electrical connections
(RE 29947/11.92)

3.1 Power supply.

The electronic control card VT 5041 |III| needs 24V DC. If necessary, this voltage can be generated with a Rexroth power supply VT 1516 (with cardholder) acc. to RE 29915/06.81. The 24V output of the power supply must be connected to terminal (30a) on the terminal strip |15|, and OV to connection (28a). Cable with a least 0,5 mm^2 two strand, or two single strand cables. For safety reasons, we recommend the use of a netfilter (f.i. FN 332-1/01 of the company Schaffner) as a precaution against voltage spikes, which occur when turning off appliances with high inductance.

3.2 General information.

• Use low capacitance cables in accordance with the VDE safety recommendations. Try to avoid intermediate wire connections.
• It is not permitted to install possible electro-magnetic interference sources close to the electronic controls.
• It is not permitted to lay power wiring close to the electronic control card.
• Do not install control wiring close to power wiring.
• Switches or relay points are not permitted in the wiring between pump / prop. valve and control card, because the interruption of a connection causes fault indication.
• Cables for the positional transducers |5| and |10| , as well as for the pressure transducer |16| must be shielded |4| . Connect the shield only on one side to the control card. Do not connect the shield onto the valve, the pump or the pressure transducer.

Cable shielding |4| for the transducers

Sheath and shield
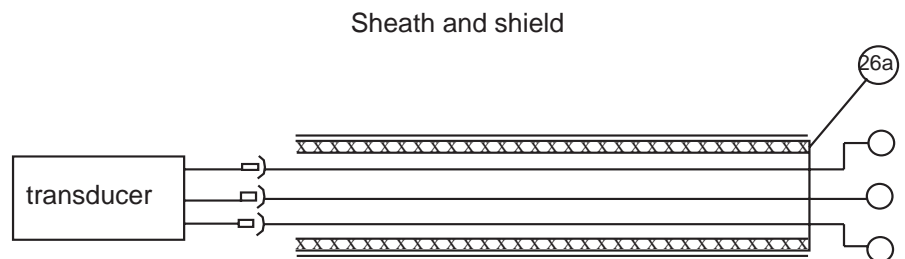
connect the shield   the exposed shield
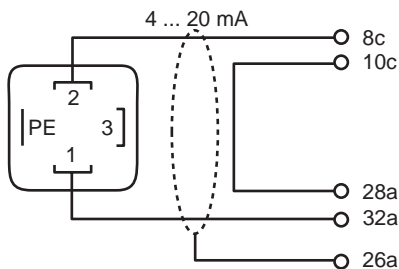to the plug onto the transducer   to be connected to 26a.

• Since it is difficult to connect all cable shields to |15| (26a) , the shields can be inter-connected. When doing this it is necessary to connect as much as possible shield
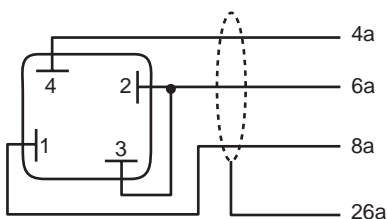

3.3 Connections on pressure transducer ⏢II⏢ with cable ⏢16⏢
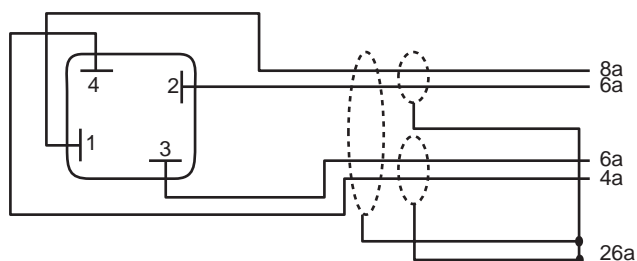
Type of cable LiYCY 2 x 0,25 mm^2

4 ... 20 mA

3.4 Valve-Stroke transducer: cable ⏢5⏢

For the connection of valve stroke transducer ⏢5⏢ we recommend the use of cable type LiYCY 3 x 0,25 mm^2 (up to 10 m cablelength).The connections 2 and 3 must be connected plug in the transducer. See the sketch below.

For lines longer than 10 m (max. 50 m) we recommend the use of 4 strand cable type LiYCF 2 x 2 x 0,25 mm^2, with pairwise shielding of conductors. In this case 2 and 3 are not connected in the plug, but on the amplifiercard. Connect all shields onto 26a .
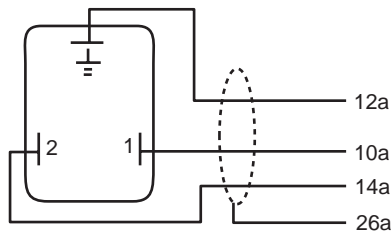
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3.5 Pump swivelangle
    transducer: cable 10

Use the following type of cable: LiYCY 3 x 0,25 mm^2

connection diagram for pump right hand rotation
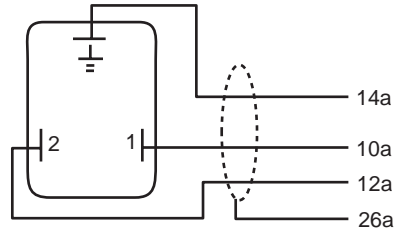
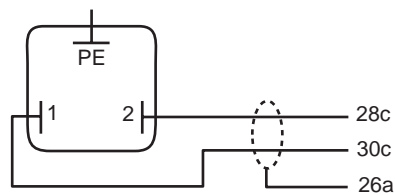connection diagram for pump left hand

3.6 Proportional valve: cable 11

Solenoid cable 11 has to be separated from other electr. lines, especially from the wiring for the inductive transducers 5 and 10.

It is recommended to shield the solenoid cable.

Type of cable LiYCY 1,5 mm^2 up to 50 m length.

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3.7 Command values for pressure [2] and swivelangle [3]

- The command values for pressure and swivelangle (flow) are normally generated in a PLC (0 ... 10 V).
- Command value settings O ... 10 V by means of potentiometer adjustment; for this we refer to potentiometer cards acc. to RE 29711: PK1; or RE 29702: PK3, or a customer-specific version.
- Switching of command values is only permitted with appropriate contacts, suitable for currents < 1 mA.
- We recommend the use of shielded conductors (connect shield with (26a)).

3.8 Command value for power control. [1]

- Possibility for external setting of max. power 0 ... 10 V
- If external inputs are not used, always connect [15] (20c) with Mo (22a).
- further information in 3.7

3.9 Release [6]

- In normal operation the contact for interlock release is always closed. In case of a malfunction, opening and renewed closing this contact can cancel the fault. Interruption of the supply voltage also enables cancellation of the fault.
- For the wiring of the release contact, we have following possibilities:

  - Fixed wiring bridge
  - relay
  - conventional switch
  - never connect enable with 0 V!

  Important !

- Before turning on the power, it is necessary to check all wiring and connections very carefully.
- Measurements on the frontside test points, or the rearside terminals [15] can only be carried out with instruments with an internals resistance Ri >100 kOhm.
- Control card [III] may only be connected of disconnected if the voltage has been switched off.

1) Only an control card VT 5041-2X/3

3.10 Additional outputs.

3.10.1 Fault indicator
low-active 15 (2c)
- Serves to indicate a fault (or a negative release) onto the overriding control.
- Reasons for fault - indication are:
  - Broken conductor in cable for pressure transducer 16
  - Actual pressure level higher than max. system pressure (> 10 V)
  - Broken conductor in cable for swivel angle transducer 10
  - Broken conductor in cable for valve stroke transducer 5
  - Broken conductor in cable for prop. valve 11
  - If no release is given 6
  - Wrong supply voltage 1 ore faulty fuse F1 [1])
  - Defect or short in auxiliary voltage on control card.
  - Overheated output stage (possible, if control card or prop. valve are defective).

3.10.2 Indications of kind of control
- Active control of swivel angle is signalled through 15 (16a) (high-active).
- Power control is signalled, when power control 15 (18a) (high-active) and swivelangle control 15 (16a) (high-active) are active.

3.10.3 Actual values.
- Nominal actual pressure level.
  (0 ... 10 V corresponding with the setting of R1 and R2)
  Can be measured on 15 (24c) (signal corresponds with testpoint (2))
- Nominal swivel angle actual value (- 10 ... + 10 V corresponding with setting of R8 and R9) can be measured on 15 (12c) . Signal corresponds with testpoint (4)).

1) only on controlcard VT 5041-2X/3

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BLOCK DIAGRAM OF CONTROL CARD VT 5041
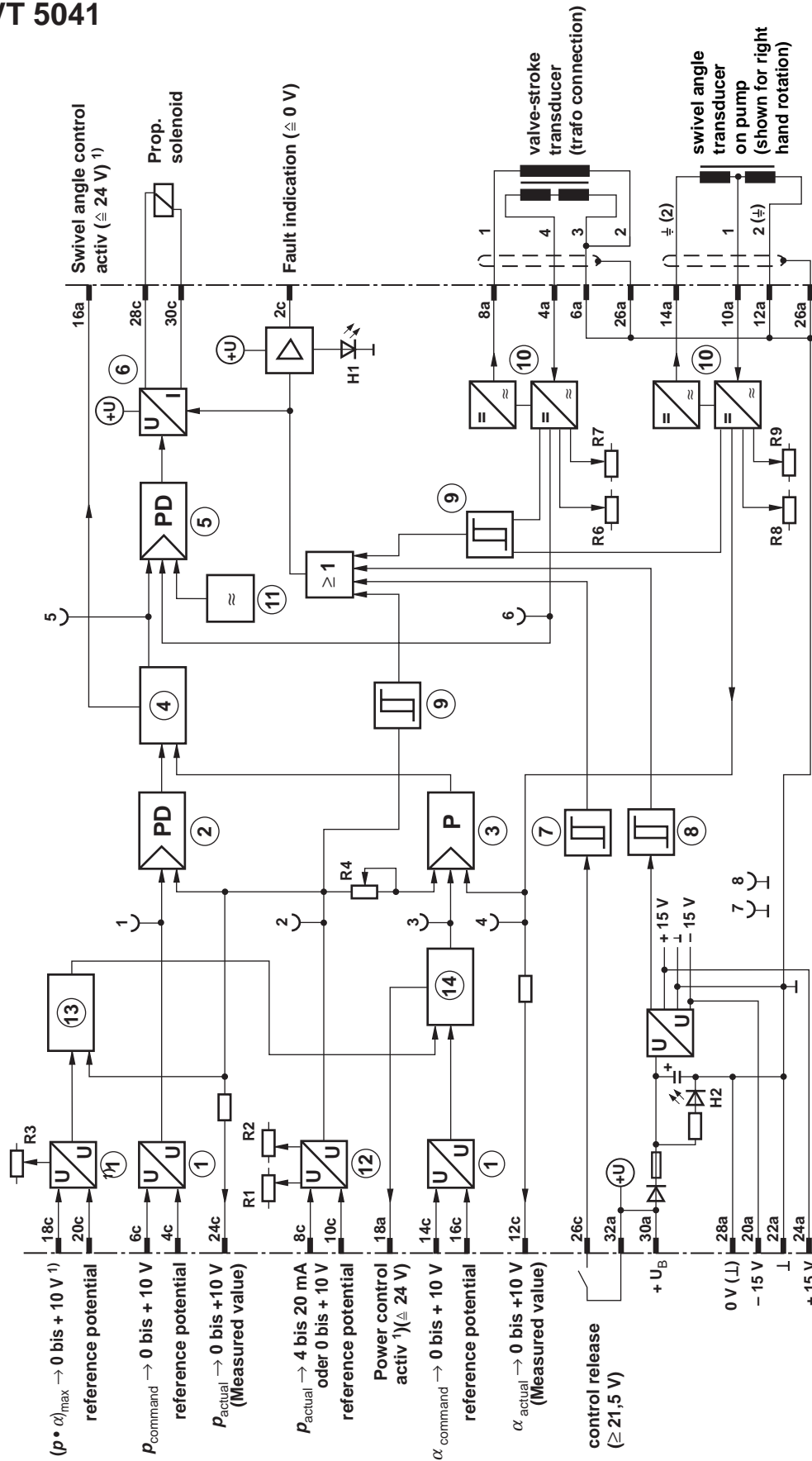
Note:
Connection of the position transducer in a throttle circuit is valid for a clockwise rotation pump
("( )" anti-clockwise rotation pump).

valve-stroke transducer (trafo connection)

swivel angle transducer on pump (shown for right hand rotation)

Swivel angle control activ (≙ 24 V) [1]

Prop. solenoid

Fault indication (≙ 0 V)

1 Differential amplifier
2 Pressure controller
3 Swivelangle controller
4 Min. value generator
5 Controller valve stroke

6 Current
7 Output stage enable
8 Monitor net symmetry
9 Cable break indicator
10 Oscillator/Demodulator

11 Dithergenerator
12 Input amplifier
13 Divider [1]
14 Min. value generator [1]

[1] only on VT 5041-2X/3..

H1 Fault indication
H2 Power
R1, R6, R8 0-point
R2, R7, R9 Amplitude
R3 fixed max. power input [1]
R4 Leckageausgleich

$(p \cdot \alpha)_{max} \to$ **0 bis + 10 V** [1]
reference potential

$p_{command} \to$ **0 bis + 10 V**
reference potential

$p_{actual} \to$ **0 bis +10 V (Measured value)**

$p_{actual} \to$ **4 bis 20 mA oder 0 bis + 10 V**
reference potential

Power control activ [1] **(≙ 24 V)**

$\alpha_{command} \to$ **0 bis + 10 V**
reference potential

$\alpha_{actual} \to$ **0 bis +10 V (Measured value)**

control release (≥ 21,5 V)

+ U_B

0 V (⊥)
– 15 V
⊥
+ 15 V

18c, 20c, 6c, 4c, 24c, 8c, 10c, 18a, 14c, 16c, 12c, 26c, 32a, 30a, 28a, 20a, 22a, 24a

16a, 28c, 30c, 2c, 8a, 4a, 6a, 26a, 14a, 10a, 12a, 26a

+ 15 V, ⊥, – 15 V

R3, R2, R1, R4, R6, R7, R8, R9

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START UP

If all hydraulic piping, and electrical wiring has been carried out correctly, the start up can take place according to the following description. If the potentiometers on the control card are not accessible during start up, a test adaptor (32 poles) is necessary (suitable Rexroth type VT 1650).

1. Turn on the supply voltage to the VT 5041-card.

(Release contact is closed)

– Green LED H2 (Power) $\boxed{7}$ lights up

– Red LED H1 (Fault) $\boxed{8}$ may not light up.

– The swivel angle display $\boxed{9}$ [1] shows approx.100 % or at the measuring socket $\boxed{4}$ approx. 8 – 10.5 V are measured. (The stopped pump is fully swashed mechanically, via the spring in the opposite spool)

If these conditions do not exist, there is a fault somewhere.

In case of a fault:

1a) Green LED (H2) $\boxed{7}$ does not light up:
    - Check supply voltage.
    - Check fuse F1 1)
1b) Red LED (H1) $\boxed{8}$ alight:
    – Enable contact 6 must be closed
    – Measure actual pressure value at measuring socket $\boxed{2}$ (must be approx. 0 V). With a negative voltage approx. -2 V solve cable break in cable $\boxed{16}$.
       The signal at the pressure transducer output has to relate to the controller card input (voltage, current, zero point).
    – If the swivel angle display $\boxed{9}$ [1] shows "minus 100" or if at the measureing socket $\boxed{4}$ approx. -10 V is measured, the cabling of the swivel angle transducer $\boxed{10}$ has to be checked.
       If none of the above occurs, then the connections of the position transducer $\boxed{5}$ of the valve and its solenoids $\boxed{11}$ have to be checked.

2. Turn off the supply voltage.

3. Repair the fault.

4. Switch on the supply voltage and the release.

2. Check connections at command inputs for pressure and swivel angle

– Set values for pressure and swivel angle, f.i. each with 1,5 V

– Measurement on test point $\boxed{1}$ must show + 1,5 v, and on test point $\boxed{3}$
    - 1,5 V. If this is not the case, check the wiring to the command inputs.

[1] only on VT 5041-2X/3

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3. Check zero point adjustment of pressure transducer

- Check voltage on test point ②: 0 V +/- 50 mV.
- If necessary adjust with potentiometer R 1

4. Turn on pump drive motor

- Please follow general start up instructions !
- Hydraulic oil temperature must be at operating level during start up.

5. Checking and correcting the valve zero point

- All directional controls must be closed. There may not be any oil flow !
- Set swivel angle command value to 10 V (Test point ③ shows - 10 V).
- Set system pressure by means of pressure command value to approx 100 bar (measure with pressure gauge).

The correct setting of the valve zero point can be measured between the measurement sockets ① and ②. With a system pressure of 100 bar there should be a voltage value of 0 V ± 0.05 V between the measurement sockets ① and ②. If the control deviation is larger (e.g. caused by deviating cable lengths), then it is possible to adjust potentiometer R6 so that it is possible to measure 0 V between the measuring sockets ① and ②.

Caution: Never change the amplitude of valve stroke transducer (R7) !!

6. Setting of system pressure

- Close all directional controls. Oil flow is not allowed !
- Set command value for swivel angle to 10 V (Test point ③ = - 10 V).

The pressure command value should be set ab 5 V. Monitor pump pressure with a pressure gauge, and keep on adjusting potentiometer R 2 [12], until pressure amounts to 50 % of max. system pressure. To check thoroughly, with command setting of 10 V, the max. system pressure (+/- 3 bar) must be reached.

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7. Pressure control
Setting the controller
parameters

- Optimization via jumper.
  J1 and J2 P-fraction
  J3 up to J5 D-fraction
- Exfactory all jumpers on „OFF"
- Adapt D-fraction to the operating oil volume:

Operating oil volume in L. (In piping and actuators)	Jumper position		
	J3	J4	J5
≤ 5	off	off	off
7,5	off	on	off
10	on	on	off
15	on	off	on
20	off	on	on
25	on	on	on

Change P-fraction only in exeptional cases; i.e. in case of an unstable pressure control. (Rough pump noise in upper pressure range.) Occurs for instance if system pressure is far below 280 bar.

P-amplification	Jumper position	
	J1	J2
4	off	off
3	off	on
2,4	on	off
2	on	on

8. Checking of swivel angle
feedback [2)]

8.1 Check feedback at pump null position (only necessary if swivel angle feed back transducer cable deviates clearly from length of 4 m).

– Directional valve(s) closed
– Swivel angle command value = 10 V
– Apply a 0 V pressure command value (a pressure of 6 to 10 bar results)
– Check, if at socket ④ a voltage of 0 V ± 0.1 V can be measured.
– Deviations can be conpensated via potentiometer R8.

8.2 Set 100 % swivel angle

– Swivel angle command value 10 V, pressure command value 5 V
– Direct the full flow via the actuator or flow counter: e.g. actuate a hydraulic motor or set the pressure relief valve to approx. 20 bar.
– Adjust potentiometer R9, so that at measureing socket ④ 10 V can be measured.

[2)] For controls with external control pressure, resp. with multiple pumps please follow the instructions on page 17 to

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9. Potentiometer R4 ⬜13 :

Leakage compensation has been factory set to compensate for pressure dependent leakage.

10.   Power control [1)]

- Calculation of pump corner power:

Power of drive motor	P_m	=	15 kW
Drive motor speed	n	=	1500 rpm
Pump displacement (Pump size)	V_g	=	100 cm³
System pressure	p_{max}	=	200 bar
Mech.hydr. efficiency	η_{mh}	=	1 (theoretical value)

$$P_{100\%} = \frac{V_g\ (cm^3) \bullet n\ (rpm) \bullet p_{max}\ (bar)}{600.000 \bullet \eta\ mh}$$

$$P_{100\%} = 50\ kW$$

- Calculation of ratio

$$(p \bullet \alpha)_{max} = \frac{P_M}{P_{100\%}} \bullet 100\% = 30\%$$

10.1 Setting of power control by means of potentiometer R3

- Connect ⬜15 Ⓞ20c with Mo ⬜15 Ⓞ22a

- ⬜15 Ⓞ18c not connected

- Directional controls closed

- Set max. pressure command value 10 V (pressure rises to p_{max} actual)

- Set swivelangle command $\alpha_{command}$ according to desired power control level:
  i.e. $\alpha_{command}$ = 3 V means $(p \bullet \alpha)_{max}$ = 30 % (as desired).

– Turn R3 in a clockwise direction until the signal "power limitation" ⬜15 Ⓞ18a becomes active or the voltage measured at measurement socket Ⓞ3 starts to decrease.

10.2 External setting of power limit (10V corresponds with $(p \bullet \alpha)_{max}$ = 100 %)

- $(p \bullet \alpha)_{max}$ as differential amplifier connect ⬜15 Ⓞ18c and Ⓞ20c .
– Turn potentiometer R3 in a clockwise direction up to its stop (pre-setting exworks: left hand stop)

[1)] only with VT 5041-2X/3

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LAYOUT OF POTENTIO-
METERS, LED,
JUMPERS AND FUSE [1]
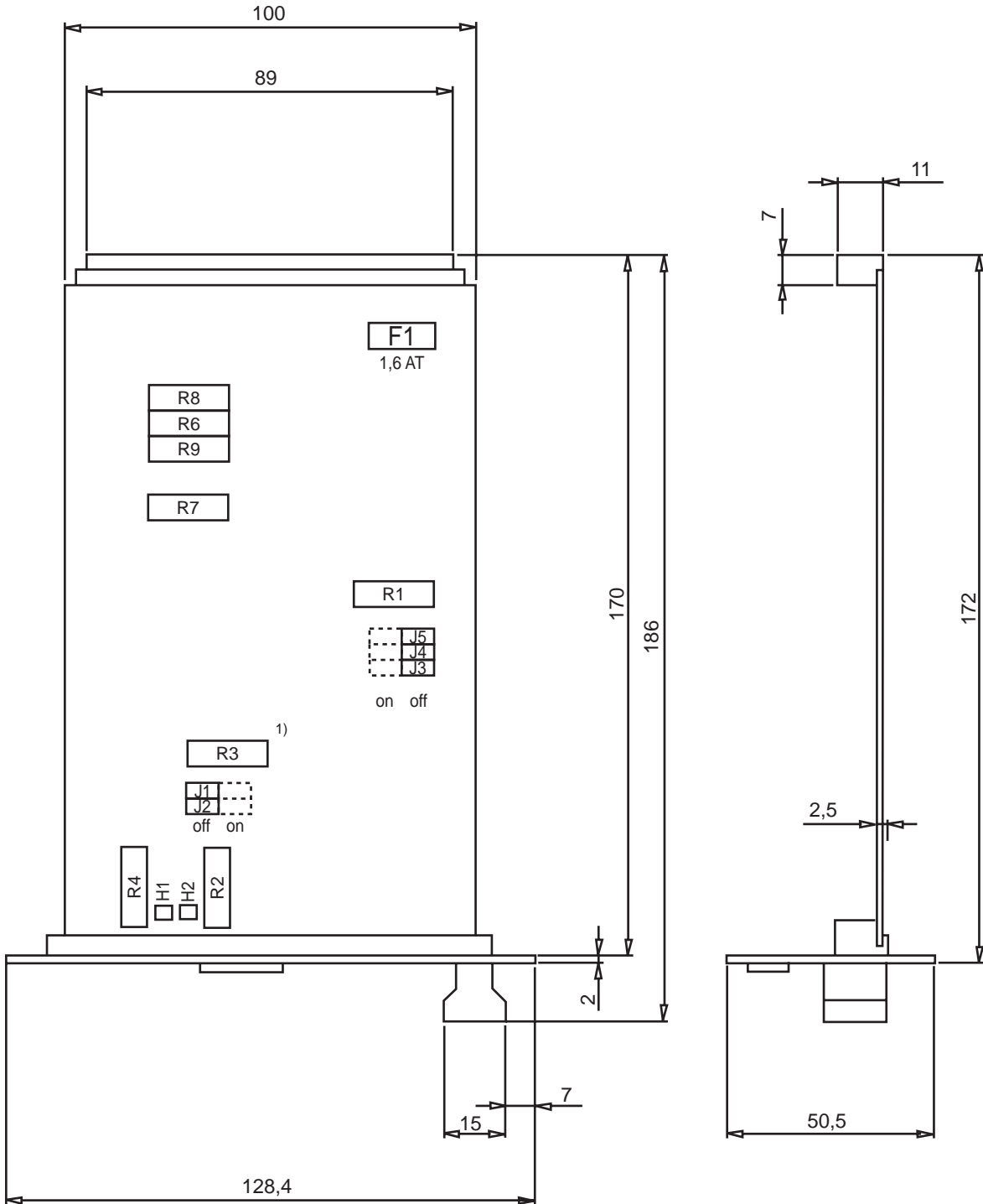
[1] only VT 5041-2X/3

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INSTRUCTIONS FOR DFE1-CONTROL SYSTEMS WITH EXTERNAL SUPPLY OF CONTROL PRESSURE (ACC. TO RE 67016/06.93, page 5)

1. In case of faults

- The safety function, which centres the pump to zero in case of loss of power in the control card output stage, is out of order with an external supply of control pressure.

- The external control pressure causes the pump to go completely over centre against the negative stop in case of a power loss in the output stage of the control card. An anti-cavitation check valve has to be installed into the pump pressure line in order to avoid cavitation.

- At fault detection the output stage is switched off (compare 3.10.1, page 12 causes of faults). During active fault finding the machine control must act (i.e. turn of pump drive motor, or disconnect supply of external control pressure).

2. Command value settings

- Operating pressures < 10 bar only in cyclic operation (max. 10 min.)
- command values for pressure and flows must always be > 0. Because of drift, or unaccuracy in adjustments pressure or swivel angle cannot be exactly 0. Command settings of 0 or close to 0 can cause cavitation under unfavourable conditions.

3. Start up: checking of swivel angle measurements

Point 8. „Check feed back of swivel angle" in the start up instructions must be changed as follows for systems with external supply of control pressure:

- Use flow meter or hydraulic motor as measuring instrument
- Swivel angle command value $\alpha_{command\ 100\ \%}$ = 10 V, pressure command value 5 V.
- Adjust potentiometer R9 until flow meter, or hydraulic motor indicate 100 % flow.
  Example: Pump size 100: V_G = 100 cm^3
          Drive motor speed   n = 1500 rpm
          volumetric efficiency η_v = 1 (theoretical max. value, can be assumed for pressures < 10 bar)

Flow:

$$Q = \frac{V_G \, (cm^3) \quad \bullet \; n \; (rpm) \; \bullet \; \eta_v}{1000} \quad \text{in (l/min)}$$

Q = 150 l/min

Adjust R9 until flow meter shows 150 l/min.

- swivel angle command value $\alpha_{command\,5\,\%} = 0{,}5$ V, pressure command value 5 V
- Adjust-potentiometer R8, until flow meter, resp. motor speed indicate 5 % flow.

  Example:

  Adjust R8 until flow meter indicates 7,5 l/min

- For a rec-check or a precise setting, repeat this procedure.

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DFE 1-
CONTROL SYSTEMS
WITH MULTIPLE
PUMP SYSTEMS

• For systems with additional external supply of control pressure, follow the preceding instructions.

1. Selection of pump size

• The DFE1-variable pump displacement has to be larger than the fixed pump displacement, otherwise pressure control is not possible.

• If the fixed displacement pump is only slightly smaller than the variable pump, the pressure decrease times will be increased.
Therefore, the variable pump should have at least 25 % more displacement than the fixed pump.

2. Command setting for the swivel angle

2.1 Setting of positive and negative voltages as the swivel angle command value.

• If it is possible to input positive or negative voltages as command values for the swivel angle control card version VT 5041-2x/.-0. can be used.

• The following formal a enables the calculation of the appropriate voltages to achieve the desired displacement:

$$\alpha_{command} = \frac{10\ V}{V_{G1}}\ (V_G - V_{G2})$$

V_G = desired displacement

V_{G1} = size (max. displacement) of DFE1 - variable pump

V_{G2} = size of fixed displacement pump

Example: V_{G1} = 140 cm^3
              V_{G2} = 71 cm^3

Calculation of command voltage resulting in „zero" displacement

$$\alpha_{command\ o} = \frac{10\ V}{140\ cm^3}\ (0 - 71\ cm^3)$$

$\alpha_{command\ o}$ = - 5,07 V

$\alpha_{command\ 100\ \%}$ = 10 V results in a total max. displacement of 211 cm^3.

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• The adjustment, resp. the checking of the swivel angle feedback is carried out as per „Instructions for DFE1-control systems with external supply of control pressure", 3. start up, in which the command value 5 % has to be changed correspondingly.
(in above example $\alpha_{command\ 5\ \%} = -\ 4{,}32$ V)

2.2 Input of only positive com-
mand voltage for swivel angle

• If only positive values as a command voltage are possible, the control card has to be adapted to the pump combination.

• On the matched controller cards the swivel angle command value $\propto_{com.}$ (from 0 to 10 V) is falsified. That is why the measurement values for the swivel angle command values (measurement socket ③, inverted) and the swivel angle actual values (measurement socket ④) are not the same. The resulting actual swivel angle values can be calculated for checking purposes:

$$\alpha_{actual} = \frac{V_{G1} + V_{G2}}{V_{G1}} \bullet \alpha_{command} - \frac{V_{G2}}{V_{G1}} \bullet 10\ V$$

• The adjustment, resp. checking of the swivel angle feedbackvalue is carried out as per „Instructions for DFE1-control systems with external supply of control pressure", 3. Start up.

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